

## **Introducing Photovoltaics to New Markets Through Government Development Programs: The FIRCO Example in Mexico**

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### **Introduction:**

The U.S. Photovoltaic (PV) Industry Roadmap stresses the need to work in partnership with the U.S. government to foster market growth for PV applications over the next 20 years. While the main thrust of the roadmap document is on the development of domestic markets for grid-tied PV systems, the developing world also represents a significant market potential, where over 1.6 billion people lack electricity and basic infrastructure. In many of these cases, PV systems will be the least-cost source of power. By the year 2020, the roadmap predicts that 4 of 7 Gigawatts of annual PV production will still go to international markets. Based on these roadmap goals, strong partnerships between government and industry will therefore be necessary both domestically and internationally.

This paper describes some results of a program in Mexico to introduce renewable energy technologies (RETs) to Mexican government-managed agricultural development programs. Through this program, Sandia National Laboratories and several partner organizations have worked with a variety of Mexican agencies. One important collaboration has been with a Mexican agricultural extension agency under the federal Secretariat of Agriculture (SAGARPA) called FIRCO (Fideicomiso de Riesgo Compartido), which has built partnerships with industry, academia, and other institutions in the development community to foster sustainable new markets for photovoltaic and wind-electric applications. Through the strengths of these partnerships, the Mexican government is now implementing the first-ever Renewable Energy for Agriculture program with sponsorship from the Global Environment Facility (GEF). The GEF is a multi-lateral organization created as an outcome of the Rio de Janeiro Earth Summit in 1992, and implements environment-related programs throughout the world.

The lessons learned and the practices adopted from the FIRCO/Sandia partnership are being applied in other countries and in the United States with American Indian development and energy organizations. Although each case is unique and has its own guiding criteria, the authors believe that such partnerships in the international arena can serve as models for domestic partnerships that will be needed for the roadmap goals to be achieved.

### **The FIRCO/Sandia Partnership**

In 1994, the U.S. Department of Energy (USDOE) and the U.S. Agency for International Development (USAID) initiated a multi-year effort to introduce productive-use applications of

RETs in Mexico, managed by Sandia National Laboratories. Sandia and its agents started to collaborate with FIRCO on its agricultural development programs. As an extension agency within the Secretariat of Agriculture, FIRCO has offices in each of Mexico's 31 states. Its mission is to improve agricultural productivity through the introduction of new technologies and procedures, as well as to manage several rural poverty-related programs. Before the partnership with Sandia, in many states, FIRCO engineers assisted ranchers and farmers in obtaining gasoline or diesel-powered water pumps to meet their needs. The combination of decentralized project implementation, a technology-based approach to rural development, and ongoing program activities where renewable energy could directly substitute, made FIRCO an ideal partner for Sandia.

Beginning in the northern Mexican states of Chihuahua and Sonora, FIRCO and Sandia teamed on the implementation of photovoltaic water pumping projects for ranchers. (In Chihuahua, FIRCO was part of a state government-led Renewable Energy Working Group.) By the end of 2000, FIRCO and Sandia have partnered with ranchers and local institutions on the installation of almost 200 pilot projects in 14 Mexican states. The program model is founded on six basic tenets:

- Teambuilding approach through the formation of strong partnerships;
- Conduct of institutional capacity building exercises;
- Implementation of pilot projects;
- Provision of technical assistance;
- Evaluation and monitoring; and
- Replication.

Detailed information about the program model and its results is provided in the references. These efforts have resulted in several strong partnerships among members of the Mexican and U.S. PV industries, and have allowed suppliers to provide better designs, a broader range of components, and better service than before. All of this has led to improved perceptions of the value of PV systems to existing and potential customers.

A significant outcome of the FIRCO/Sandia partnership is the level of support that the Mexican federal government has shown for the implementation of RETs in its program structure. This has required formalizing and enacting basic policy changes within several government programs in which FIRCO plays a role, such as Alliance for the Countryside, Temporary Employment, and the Drought Program. Each of these is a federal program aimed at helping to increase agricultural production, and each has enacted fundamental changes to include the demonstration of PV and other renewable energy projects.

### **The FIRCO “Renewable Energy for Agriculture” Program**

Based on its partnership with Sandia, FIRCO initiated a five-year program in the year 2000 to broadly demonstrate the value of RETs in several applications across Mexico. The program goal is to initiate sustainable markets for RETs in all of Mexico's 31 states. Loan financing to the Mexican Government comes from the World Bank, and the program is funded through a Global

Environment Facility grant, the Mexican government, and a significant investment component from end-users. Program goals include the implementation of 1152 PV water pumping systems, 55 wind water pumping systems, and 24 milk cooling tanks, along with several capacity-related goals. This is an ambitious program, and its success will depend on the strength of the partnerships that FIRCO is building with organizations in both the public and private sectors in Mexico.

In a concerted effort to ensure the long-term viability of the new markets that will be developed, FIRCO has designed several components of the program that focus on capacity building and institutional strengthening in addition to the installation of demonstration projects. At the core of the program is the formation of partnerships with the private sector and other institutions. Table 1 shows the program areas and lists the types of partnerships being developed. This program structure comes largely from the experiences and lessons learned through the FIRCO/Sandia pilot program.

<b>Program Component</b>	<b>Investment (\$ million)</b>	<b>Partnering Opportunities</b>
Promotion and Publicity	\$1.8	
Training	\$1.6	<ul style="list-style-type: none"> <li>- Suppliers</li> <li>- Independent technicians</li> <li>- State agencies</li> <li>- Ranchers associations</li> </ul>
Demonstration Projects	\$18.8	<ul style="list-style-type: none"> <li>- Suppliers</li> <li>- U.S. suppliers</li> </ul>
Technical Assistance	\$4.9	<ul style="list-style-type: none"> <li>- Suppliers</li> <li>- Agricultural organizations</li> </ul>
Market Development	\$0.7	<ul style="list-style-type: none"> <li>- Renewable energy suppliers</li> <li>- Suppliers in other industries (diary, irrigation, etc.)</li> </ul>
Vendor Financing Pilot	\$2.3	<ul style="list-style-type: none"> <li>- Suppliers</li> <li>- Financial institutions</li> </ul>
Specifications and Certification	\$0.3	<ul style="list-style-type: none"> <li>- Universities</li> <li>- Laboratories</li> </ul>
Project Management	\$1.0	
Total:	~ \$31.3 million	

**Table 1: The components of the FIRCO Renewable Energy for Agriculture Program.**

As Table 1 shows, these program components combine to develop new sustainable markets for agricultural applications of renewable energy equipment. A discussion of these program aspects follows:

*Promotion and Publicity:* This includes the preparation and dissemination of brochures, pamphlets, posters, and radio announcements, all of which will be focused on increasing the awareness of RET benefits among Mexican farmers, vendors, and development agencies.

Promotion events include producer workshops, demonstration events, and participation in fairs and expositions.

*Training:* The goal of this activity is to increase the capacity several constituent groups: renewable energy equipment and service suppliers to meet agricultural needs; technicians to design and install systems; state agencies to review project proposals; and in-country agricultural extensionists to advise producers on renewable energy applications and project design. Training courses are planned for more than 3000 engineers, technicians, decision-makers, and other beneficiaries during the life of the program. Also as part of this aspect of the program, and to assure open communication among participants, annual regional and national seminars are being conducted for experience and informational exchanges.

*Demonstration Projects:* The perceived risks of ranchers and farmers in adopting new technologies will be reduced through the nationwide partnered implementation of demonstration projects. The costs of these installations will be shared by the FIRCO/GEF program, a federal agricultural loan package from the World Bank, and the beneficiary producers. All of the projects listed in Table 1 will be implemented in this manner.

*Technical Assistance:* To ensure the quality of the demonstration projects and to disseminate experiences among producers, technical assistance will be provided at all stages of the project implementation process. The program will utilize trained groups of agricultural extensionists, and will partially support their provision of assistance to producers.

*Market Development:* By conducting detailed assessments of the market potential for RETs, the FIRCO program aims to reduce uncertainty and encourage entry of vendors and service providers, and to encourage the development of new applications packages. In this regard, technology and market assessments will be conducted for milk storage tanks, wind water pumping, dairy mechanization, and for biomass and solar thermal applications in agriculture.

*Vendor Financing Pilot:* While rural credit mechanisms in Mexico are still considered non-functional as a result of the 1994 peso crisis, it was considered imperative by the GEF that end-user financing be addressed in this program. The result is a 4-state pilot activity directly involving equipment vendors, either through vendor on-lending or working in collaboration with finance companies.

*Specifications and Certification:* In order to increase end users' confidence in the technologies, FIRCO has included a program component to develop system specifications and certification procedures. These are being adopted from existing materials, and will help to assure the quality of PV and wind water pumping systems as well as other application packages. Certification procedures will be created for equipment vendors and technicians, and not for specific components.

Clearly, the private sector plays a critical role in each of these program elements. FIRCO is already working with suppliers of renewable energy systems and other agriculture-related products to develop a strong infrastructure for the supply and maintenance of renewable energy products within this program. Private suppliers are participating in the training activities, both as

instructors and as attendees. Local suppliers are contracted to do the demonstration installations, and to participate in related capacity building and promotional activities. Vendors are both providers and recipients for the technical assistance and market development activities, and the financing activities will fully depend on strong relationships with vendors in the four pilot states.

FIRCO is also strengthening its partnerships in the academic sector to establish a basis for sustainability of the program efforts. Several universities and technological institutes are developing training and technical assistance programs geared toward directly assisting this program. In fact, the majority of the promotional events – more than 1000 courses, workshops, expositions, regional meetings, and other outreach activities – will be coordinated with universities and colleges across Mexico.

Since the inception of the FIRCO/GEF program, Sandia National Laboratories and its partners have contributed in ways that are designed to help assure long-term viability of the markets to be developed. Over the past two years, 32 FIRCO engineers have been trained in four 3 to 6-week in-depth courses held at New Mexico State University to "Train the FIRCO Trainers." These specially trained engineers are now training other FIRCO engineers, vendors, and ranchers through a series of 28 state training courses across Mexico in which Sandia is also assisting. In addition, as part of the Sandia team, the Energy Research Center of the National Autonomous University (UNAM/CIE) is devising a continuing education program for future training of FIRCO engineers. Sandia has produced several guidance and training documents that are being used by FIRCO, and Sandia continues to provide technical assistance in the development of a standard system specification and certification programs. Sandia-provided technical assistance is also helping FIRCO in the development of new applications packages. All of these activities are conducted in the context of developing long-term, sustainable markets for RETs.

### **Applications of This Program Model in Other Arenas**

The FIRCO/GEF program is based on a long-established partnership between FIRCO and Sandia National Laboratories. The FIRCO/Sandia implementation model has thus far survived the test of time and Sandia is using it in various forms for other partnered implementation activities. These activities are underway in Mexico, Central America, and in the United States as well.

In Mexico, Sandia is partnering with several other federal government agencies and their local partners to increase the use of PV technologies within their programs. For instance, the Secretariat of Public Education (SEP) currently has over 15,000 middle schools participating in its national *Telesecundaria* distance education program, which is recognized globally as an excellent means to provide quality educational curricula to schoolchildren in remote communities. Although more than 500 of these schools are powered by PV systems, SEP is experiencing operational difficulties with many of these PV installations simply due to a lack of knowledge. The Sandia team is providing technical assistance to help SEP personnel at the federal and state levels to improve their utilization of PV technology. All participants agree that with increased confidence and improved institutional capacity, many, many more rural schools in Mexico can join the tele-education network through the utilization of PV systems.

The Mexican Secretariat of Energy (SENER) is proposing an “Off-Grid Rural Electrification Program” to the World Bank and GEF to introduce innovative sustainability models in the Mexican states of Chihuahua and Quintana Roo. This proposed program includes a multi-sectoral approach combining productive-use projects, community services, and household electrification, and a focus on sustainability through cost-recovery, end-user financing, and increased roles for the private sector. Through its Mexico program model, Sandia and its partners are providing technical support to the definition of the program, and are also planning to assist in its implementation.

The Mexican Secretariat of Environment and Natural Resources (SEMARNAT) is developing a program to use renewable energy technologies in Mexico’s protected areas, based on past partnered activities with Sandia, through which more than 70 renewable energy systems were installed in protected areas. Applications include the electrification of field, research, and visitor stations, communication systems, and water pumping. Sandia and SEMARNAT are investigating project opportunities in the core zones of protected areas and in the buffer communities that lie on the outskirts of these zones.

Figure 1 shows a graph of estimated future installations of renewable energy systems (mostly PV) by Sandia’s Mexico Renewable Energy Program governmental partners in Mexico as compared to Sandia cost-shared pilot installations. The programs of SEP (Rural Off-Grid Tele-Education), SENER (Rural Off-Grid Rural Electrification), and FIRCO (Renewable Energy for Agriculture) are included. Installation potential of the SEMARNAT program has not yet been estimated.

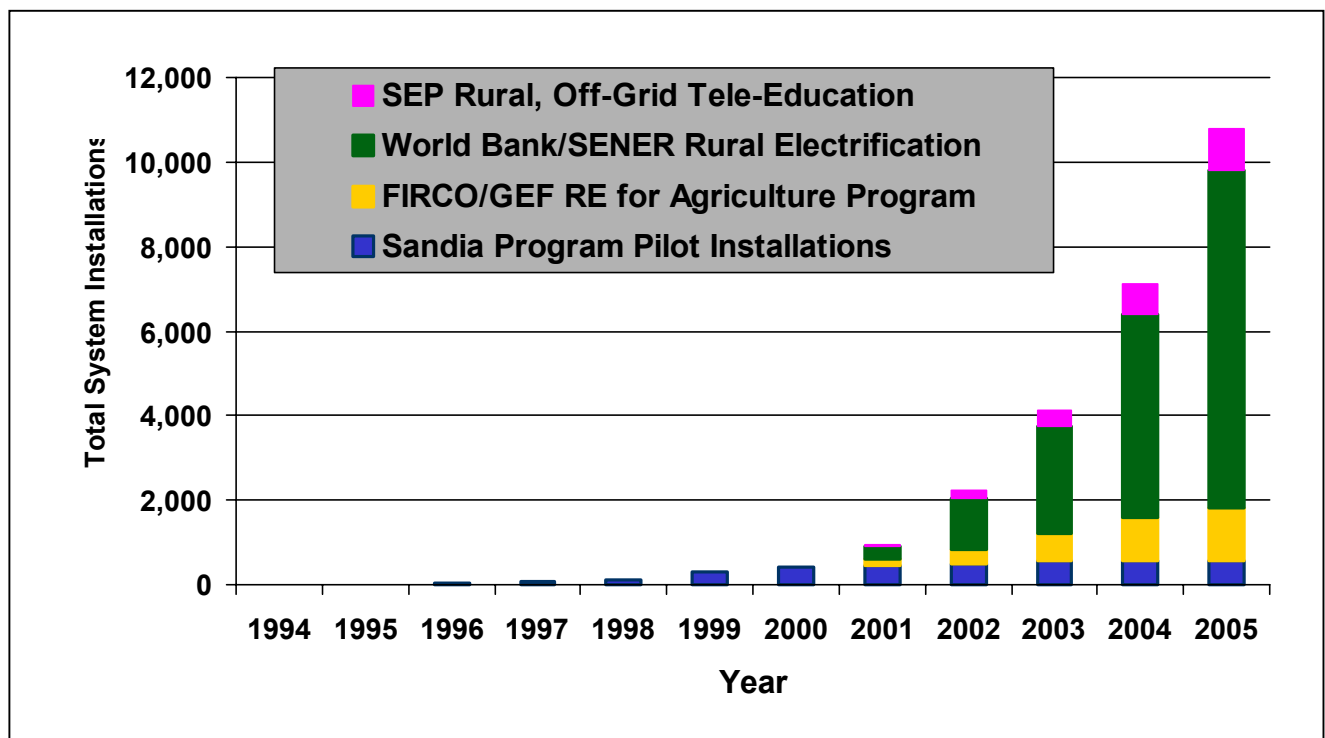


Figure 1: Estimated future RET system installations by Sandia's governmental partners in Mexico.

Sandia and FIRCO are using the Mexico program model to build partnerships in other parts of Latin America that will help to develop new sustainable markets for PV and other RETs in the region. With support from USAID and USDOE, and in close partnership with in-country development organizations and suppliers of systems, Sandia is installing projects in Guatemala and Honduras to demonstrate PV water pumping and the application of PV for distance education and the management of protected areas. Mexican partner organizations – including FIRCO – are helping to build a regional network of information flow and industry relationships. After a year of activities in Central America, Sandia is implementing partnered projects with the Ministries of Education of Guatemala and Honduras, the UN Food and Agriculture Organization, and several important foundations in both countries. In addition, FIRCO continues to host agricultural specialists from countries throughout Latin America in courses and field trips to demonstrate the use of PV in agricultural applications. All of these activities are being conducted in close collaboration with local suppliers of PV equipment.

Sandia is also applying the Mexico program model domestically, to coordinate the many outreach activities that the PV and other renewable energy programs are conducting with American Indian populations. Sandia has been working with Native Americans for more than a decade, principally through the outreach activities of the DOE-sponsored PV program. These activities are now being repackaged into a strategic program with the goal of building capacity within American Indian institutions to develop and grow strong markets for a variety of PV applications. On the Navajo Nation, Sandia is helping the Navajo Tribal Utility Authority to decentralize the management of their successful PV program and to train customers and field technicians in aspects of proper use and maintenance of the installed systems. All of this is being coordinated with the U.S. industry supplier of the systems. These efforts are being expanded to other tribes in New Mexico, and technical support activities are being conducted with several tribes across the Western U.S.

## **Conclusions**

As the U.S. PV industry works to meet its goals for market penetration by the year 2020, the need for public/private partnerships – both domestically and internationally - will continue to grow. In addition to private sector-led activities, the introduction of PV technologies through government-led development programs requires strong partnerships with the private sector to ensure stable and sustainable market growth. In Mexico, FIRCO and Sandia have worked to develop new markets for PV water pumping systems and other RET applications. These efforts have resulted in new public/private partnerships that have led to improved system designs and installations, better maintenance practices and availability of spare parts; and increased consumer confidence. Based on these results, FIRCO is now implementing the first-ever GEF-sponsored renewable energy for agriculture program, through which even stronger partnerships with members of the PV industry will be developed. This general program model is being used in

other parts of Latin America and in the United States to develop partnerships that will lead to new, growing markets for PV products.

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